HISTOGENESIS IN INSECT DEVELOPMENT, AND CELL SPECIFICITY.

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In the development (ontogeny) of insects with complete metamorphosis the imaginal antennæ, mouth-parts, legs and wings are produced from small buds, or histoblasts, in the larval derm. These histoblasts or imaginal buds arise by the shallow or deep invagination (one for each histoblast) of small regions of the larval cellular skin layer including originally, in each case, only comparatively few derm cells. The position of these invaginations, and therefore the participation of derm cells in the future leg or wing development, seems to be determined wholly with reference to the future imaginal organ, and not at all with reference to any difference in degree of differentiation among the cells of the larval derm. The wing-buds arise from the latero-dorsal regions of the meso- and meta-thoracic segments, the leg-buds from the latero-ventral regions of each of the three thoracic segments.

The larval derm is certainly not to be looked on as composed of wholly undifferentiated embryonic cells. These derm cells make up a definite organ, or part, of the larval body, with definitive position and particular functions. All these cells, and no others in the body, secrete[1] chitin ; some of them secrete noxious fluids, ill-smelling, acrid, poisonous. Many of them, perhaps all, secrete moulting fluid at the times of the regular larval moults ; many are specially sensitive, many bear sense-hairs or papillæ.

The invagination and beginning development of small parts of this derm, in a wingless and legless larva of a fly or honeybee or of some other specialized insect, may occur in a very early larval stage (in some cases, indeed, indications of the future histoblasts are apparent in just-hatched larvæ), but in most cases the invagination does not appear until a certain part of the free larval life has been lived. That is, the larval derm has for awhile

[1] The chitin secreting capacity of the anterior and posterior thirds of the insect alimentary canal is due to their deeply invaginated derm.

subserved only, and has subserved fully, the functions of skin, and its cells have certainly attained whatever differentiation they need for the performance of these functions. It is far and away a long cry back to the embryonic, undifferentiated, the non-specific condition. But apparently any part or region of this derm which may, by its position, be the region or part needed to develop an antenna, a wing, a leg, male clasper, female ovipositor, or a sting, can respond to the need, and by invagination (for protection's sake), rapid growth and proliferation of cells, quick differentiation and arrangement, and final evagination (at the time of the last larval moulting, *i. e.*, pupation) produce the needed organ. This organ may be tubular and segmented, and the segments may be similar (antennæ); or dissimilar (leg); or it may be a great flattened sac, supported by tubular skeletal ribs and covered by a million and more tiny other striated, pigment-bearing, flattened sacs (the butterfly's wing with its scales); or it may be the exquisite mechanism of the bee's sting.

This histogenesis of the imaginal parts of the fly, the bee, and the moth is, to my mind, an extremely suggestive phenomenon when considered in the light of its relation to the theories of cell-specificity or cell-non-specificity. Quite as positively as the more familiar cases of restorative regeneration (legs, eye-lenses, tails and what not of various vertebrates), does this radical histogenesis, common to the ontogeny of all insects with complete metamorphosis, make it impossible to limit the germ-plasm to the germ-cells. It stands strongly opposed to any theory of absolute cell-differentiation or cell-specificity.

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